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ANALYSIS OF Bi-2223 PHASE GROWTH IN Ag-SHEATHED $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10+\delta}$ TAPES

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The evolution of the Liquid Phase (LP), the dissolution of the Bi-2212 phase and the growth of the Bi-2223 phase in sintered (Bi, $Pb)_2Sr_2Ca_2Cu_3O_{10+\delta}$/Ag tapes were investigated by SEM, EDS and XRD. The samples were sintered at 840 ^oC in 8.5% O_2 and quenched in air after sintering for 1, 2, 3, 5, 10, 20 and 50 hours.

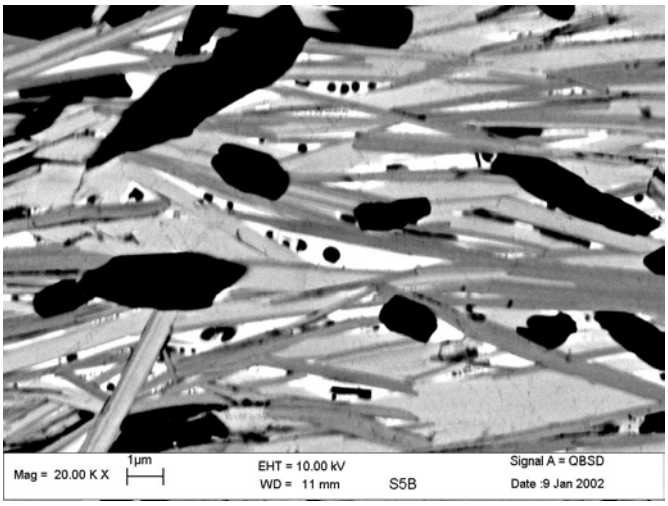

Fig. 1. The cross-section SEM images of sample sintering for 5 hours at 840 ^oC in 8.5% O_2. The white regions, the light grey regions and the dark grey regions represent LP, Bi-2212 phase and Bi-2223 phase, respectively. "jam-state" means the liquid region was covered by the Bi-2223 plates.

The cross-section SEM image of the sample sintered for 5 hours is shown in Fig. 1. It can be clearly observed that Bi-2223 phase always formed at the interfaces between the Bi-2212 phase and the liquid phase, indicating that Bi-2223 easily grows along the a-b plane of Bi-2212, and the Bi-2223 grains grow much faster along the ***ab*** plane than along the ***c***-axis. EDS analysis shows that the liquid region is rich in Bi, Pb, Ca and Cu, as originally reported by Morgan et al.[1], which implies that the Bi-2212 phase melt first to form the liquid phase and then the secondary phases dissolve into the liquid. It is also seen that some liquid regions were covered by the Bi-2223 plates, and we call this condition the "jam-state" (see Fig. 1). The average thickness along c-axis of Bi-2223 plates was obtained by measuring about 100 Bi-2223 plates. The thickness as a function of sintering time is shown in Fig. 2, which shows that the thickness increases with the sintering time, while the average growth rate of the Bi-2223 plate thickness decreases as the sintering time increases.

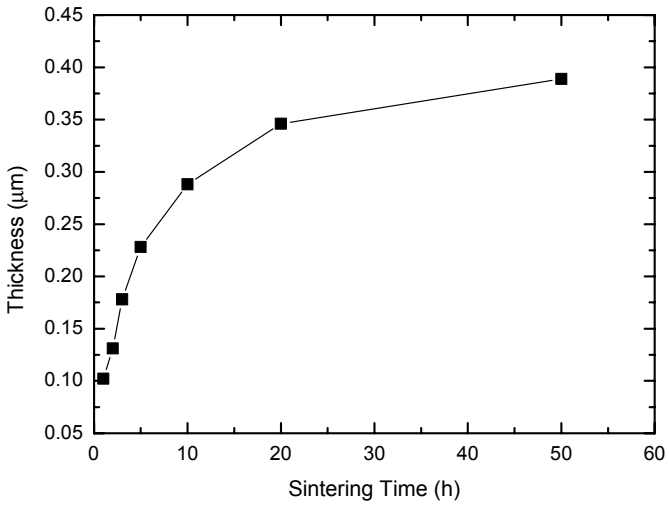

Fig. 2. The average thickness of Bi-2223 plates as a function of the sintering time.

The volume fraction of LP was measured by calculating the total area of all LP. It is found that the volume fraction of LP increases with sintering time and reaches maximum at a sintering time of 10 hours. Within the initial 10 hours, the increase of LP volume fraction is dominant; this is because that not all the liquid regions reach the "jam-state". Those that haven't reached the "jam-state" will dissolve the Bi-2212 phase plus secondary phase and grow larger continually. After sintering time of 10 hours, all liquid regions were covered by the Bi-2223 plates, the pure ***c***-axis growth of Bi-2223 phase begins. Since the growth of Bi-2223 plates consumes LP, and there is no supplementary to the LP, the total volume fraction of LP begins to fall down after 10 hours. The analysis of Bi-2223 growth using the Avrami equation reveals a two-stage kinetics process with a remarkable change of the n-exponent after about 10 hours' sintering, which can be well explained by the evolution of LP and the way of Bi-2223 phase growth.

REFERENCES

1. P. E. Morgan, R. M. Housley, J. R. Porter and J. J. Ratto, Physica C. **176,** 279 (1991)